RTCA SC-209 Working Group #1

Meeting #4, RTCA
4 – 6 December 2007

Review of issues with ED-73B/C Test Procedure Section 5.4.7.2.e

R.H. Saffell
Rockwell Collins, Inc. / RTCA SC-209

With comments of Pierre Ruault (19/11/07)

With Update by RHS (12/03/2007

SUMMARY

This document addresses simultaneous interrogation decode issues with the test procedure provided in section 5.4.7.2.e of Eurocae ED-73B/C. Such issues were discovered during discussion of commentary, review, and update of WG-49N8-17 (A5/06) in regards to Interference Testing.

SEE PAGE 3:

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RHS Introductory Commentary 12/03/2007:

Much of the dialogue provided in this document proceeds from the confusion regarding ED-73C section 5.4.7.2.e, step 5 interference testing. During some heated discussions at the WG-49 Cologne Meeting, it became obvious that Step 5 was trying to test several different conditions with only one test and that the conditions were contradictory making interpretation of the test impossible. During the Cologne meeting, RHS agreed to modify the test appropriately for the multiple conditions.

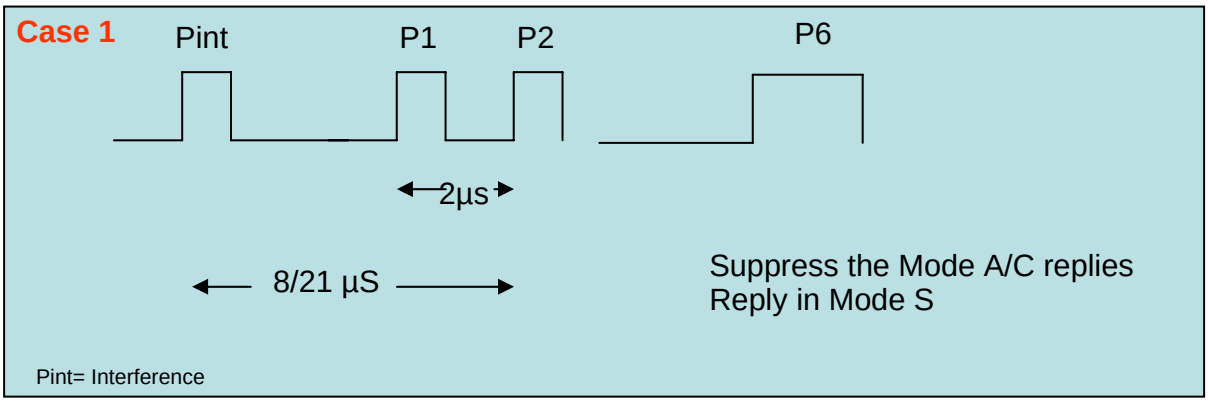
Of import are inputs provided by Pierre Ruault, Eurocontrol, where he produces 4 cases for consideration. These cases are discussed in detail in the next pages through page 8 and are the major concern in completing this document. Most of the dialogue provided from page 8 to the final analysis provided on page 22 is dialogue generated in attempting to understand the original 5.4.7.2.e, step 5 and attempting to merge other input.

Note that all text added in this document version by RHS is in GREEN font. Inputs from PR include the CASE 1 through CASE 4 figures, multiple inserts from applicable specifications, and other comments as annotated. It should be noted that the original issue that was addressed does not start until page 12 with "3.12.2 Simultaneous Interrogations of Mode A and Mode C". This issue has now been expanded in discussion through page 12 and then finalized on page 22.

PR_Comment :

Theoretical approaches related to simultaneous interrogations

Four cases can be imagined related to the simultaneous interrogations

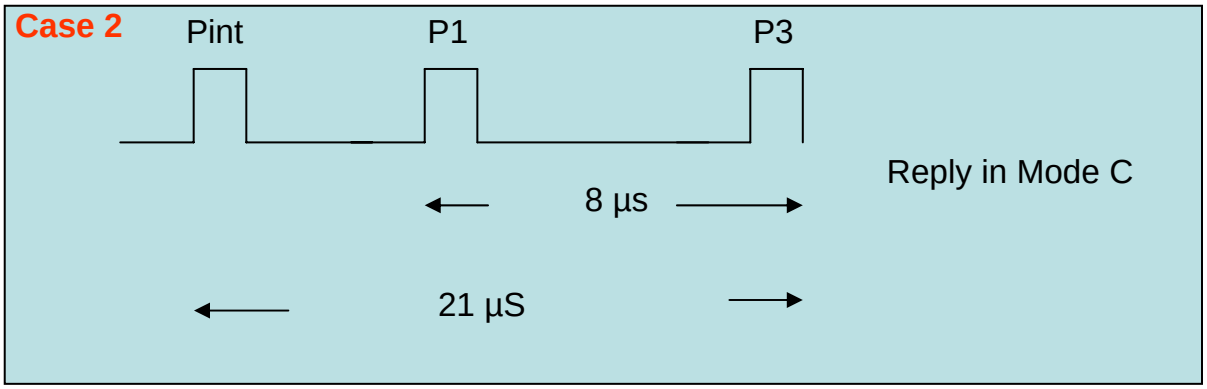


RHS_Comment_11/27/2007 :

In Case 1, the transponder must suppress all ATCRBS, e.g., Mode A/C replies, for the duration of the ATCRBS timer as soon as it detects a valid P1-P2 pair.

The transponder must then go on to process the Mode-S interrogation. Therefore, Mode A/C is suppressed (NO Reply) and Mode S is replied to.

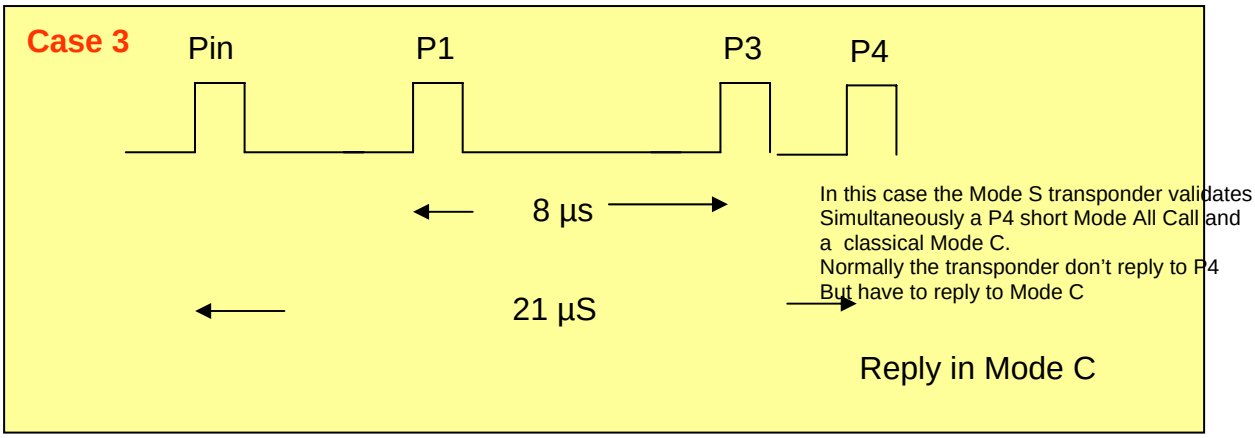
PR_Comment :



RHS_Comment_11/27/2007 :

Case 2 presents no problem as there is a simultaneous decode of a Mode A and a Mode C interrogation. In this case, the transponder must reply with Mode C in accordance with Annex 10, section 3.1.2.4.1.1.1 *Mode A and Mode C interrogation recognition.*

PR_Comment :



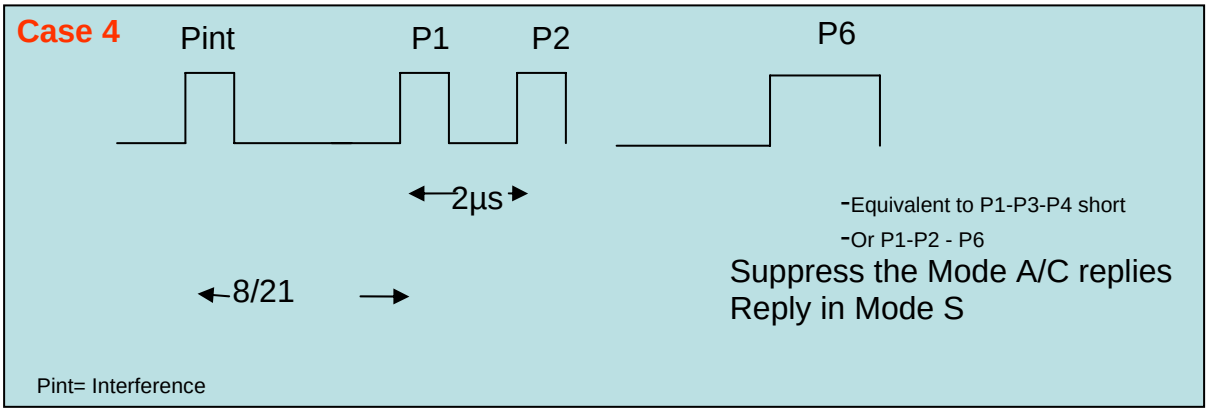
RHS_Comment_11/27/2007 :

First, Case 3 is NOT a simultaneous decode of Mode A- Only All-Call and a valid Mode C interrogation. Upon detection of a valid P1-P3 pair (Latched P1-P3), the transponder must be prepared to reply and have the reply going out within 3.0 +/- 0.5 microseconds. As such, the transponder is already in a transaction state as it is prepared to reply.

Upon detection of a minimum P4 (0.3 microseconds), the transponder has two possible choices : either discard the interrogation and reset, or be ready to reply with a DF=11 within 128 +/- 0.25 microseconds. Upon determining that the P4 is short (0.8 microseconds nominal), the transponder must reject the interrogation, reset and be prepared for the next incoming interrogation.

As such, there should be NO REPLY to Case 3.

PR_Comment :



RHS_Comment_11/27/2007 :

Note that the interference pulse is at Mode A or Mode C spacing ahead of the P1 Pulse. This results in a simultaneous decode of a Mode A/C-Only All-Call (intermode) interrogation and a P1-P2 suppression pair.

RTCA DO-181C and DO-181D provide the following in regards to acceptance of the Case 4 interrogation :

2.2.16.2.2 Interrogation Acceptance Protocol (Figure 2-11) [DO-181D, v1-1, section 2.2.18.2.2)

k. Transaction Cycle – If the transponder is in a transaction cycle, it shall not accept interrogations.

The transaction cycle begins when the transponder has recognized an interrogation type and ends when the transponder has finished the reply or has aborted processing this interrogation.

Note: A Mode S interrogation is recognized when the sync phase reversal has been detected. The transaction cycle ends when either the interrogation has been accepted and has been replied to, or when the interrogation has not been accepted because of wrong address, lockout, etc.

An ATCRBS interrogation is recognized when a proper P1-P3 interval has been detected and a following leading edge of a P4 has not been detected.

During ATCRBS suppression intervals recognition of P1 - P2 - P3 intervals is suspended.

In the interval between P1 and an expected P3, a transponder is not in a transaction cycle.

2.2.5.1 Side Lobe Suppression, ATCRBS, ATCRBS-Only All-Call, and ATCRBS/Mode S All-Call

The transponder shall react to side lobe interrogations as follows:

d. Side Lobe Suppression Characteristics

(5) The two-pulse sidelobe suppression pair shall initiate suppression in a Mode S transponder regardless of the position of the pulse pair in a group of pulses, provided the transponder is not already suppressed or in a transaction cycle (2.2.16.2.2 k.).

Next, ICAO Annex 10, Volume IV provides the following in regards to the Case 4 interrogation acceptance :

3.1.2.4.1 ***Transponder transaction cycle***. A transponder transaction cycle shall begin when the SSR Mode S transponder has recognized an interrogation. The transponder shall then evaluate the interrogation and determine whether it shall be accepted. If accepted, it shall then process the received interrogation and generate a reply, if appropriate. The transaction cycle shall end when:

a) any one of the necessary conditions for acceptance has not been met, or

b an interrogation has been accepted and the transponder has either:

1) completed the processing of the accepted interrogation if no reply is required, or

2) completed the transmission of a reply.

A new transponder transaction cycle shall not begin until the previous cycle has ended.

3.1.2.4.1.1 ***Interrogation recognition***. SSR Mode S transponders shall be capable of recognizing the following distinct types of interrogations:

a) Modes A and C;

b) intermode; and

c) Mode S.

Note.— The recognition process is dependent upon the signal input level and the specified dynamic range (3.1.2.10.1).

3.1.2.4.1.1.1 ***Mode A and Mode C interrogation recognition***. A Mode A or Mode C interrogation shall be recognized when a *P*1 - *P*3 pulse pair meeting the requirements of 3.1.1.4

has been received, and the leading edge of a *P*4 pulse with an amplitude that is greater than a level 6 dB below the amplitude of *P*3 is not received within the interval from 1.7 to 2.3 microseconds following the leading edge of *P*3.

If a *P*1 - *P*2 suppression pair and a Mode A or Mode C interrogation are recognized simultaneously, the transponder shall be suppressed. An interrogation shall not be recognized as Mode A or Mode C if the transponder is in suppression (3.1.2.4.2). If a Mode A and a Mode C interrogation are recognized simultaneously the transponder shall complete the transaction cycle as if only a Mode C interrogation had been recognized.

3.1.2.4.1.1.2 ***Intermode interrogation recognition***. An intermode interrogation shall be recognized when a *P*1 - *P*3 -*P*4 pulse triplet meeting the requirements of 3.1.2.1.5.1 is received. An interrogation shall not be recognized as an intermod interrogation if:

a) the received amplitude of the pulse in the *P*4 position is smaller than 6 dB below the amplitude of *P*3; or

b) the pulse interval between *P*3 and *P*4 is larger than 2.3 microseconds or shorter than 1.7 microseconds; or

c) the received amplitude of *P*1 and *P*3 is between MTL and –45 dBm and the pulse duration of *P*1 or *P*3 is less than 0.3 microsecond; or

d) the transponder is in suppression (3.1.2.4.2).

If a *P*1 – *P*2 suppression pair and a Mode A or Mode C intermode interrogation are recognized simultaneously the transponder shall be suppressed.

3.1.2.4.2 ***SUPPRESSION***

3.1.2.4.2.1 ***Effects of suppression***. A transponder in suppression (3.1.1.7.4) shall not recognize Mode A, Mode C or intermode interrogations if either the *P*1 pulse alone or both the *P*1 and *P*3 pulses of the interrogation are received during the suppression interval. Suppression shall not affect the recognition of, acceptance of, or replies to Mode S interrogations.

3.1.2.4.2.2 ***Suppression pairs***. The two-pulse Mode A/C suppression pair defined in 3.1.1.7.4.1 shall initiate suppression in a Mode S transponder regardless of the position of the pulse pair in a group of pulses, provided the transponder is not already suppressed or in a transaction cycle.

Note.— The P3 - P4 pair of the Mode A/C-only all-call interrogation both prevents a reply and initiates suppression.

Likewise, the P1 - P2 preamble of a Mode S interrogation initiates suppression independently of the waveform that follows it.

Last, ED-73C provides the following in regards to the Case 4 interrogation acceptance :

3.22.2.2 Interrogation Acceptance Protocol (Figure 3-10)

k. Transaction Cycle - If the transponder is in a transaction cycle, it shall not accept interrogations.

The transaction cycle begins when the transponder has recognized an interrogation type and ends when the transponder has finished the reply or has aborted processing this interrogation.

NOTE: *A Mode S interrogation is recognized when the sync phase reversal has been detected. The transaction cycle ends when either the interrogation has been accepted and has been replied to, or when the interrogation has not been accepted because of wrong address, lockout, etc.*

A Mode A/C interrogation is recognized when a proper P1-P3 interval has been detected and a following leading edge of a P4 has not been detected.

During Mode A/C suppression intervals recognition of P1 - P2 - P3 intervals is suspended.

In the interval between P1 and an expected P3, a transponder is not in a transaction cycle.

3.8 SIDE LOBE SUPPRESSION CHARACTERISTICS

3.8.1 General

e. The two-pulse sidelobe suppression pair shall initiate suppression in a Mode S transponder regardless of the position of the pulse pair in a group of pulses, provided that the transponder is not already suppressed or in a transaction cycle.

Having reviewed the applicable specification and particularly DO-181, the literal interpretation is that upon detection of a valid P1-P3, the transponder is in a transaction cycle which will not be cleared until processing of the P4 is complete. In this case, the P4 is a short P4 and the transponder should reset in order to be prepared for the next incoming interrogation. This is interpreted as the MINIMUM requirement which is the intent of the MOPs.

As such, the interpretation above says that the transponder shall not reply____especially not with an ATCRBS repl. However, it is noted that a more robust implementation would allow processing of the P1-P2_P6 and product a Mode-S reply. This would result in the transponder being more immune to the interference pulse yielding a transponder that exceeds the minimum requirements of the applicable specifications.

AT THIS POINT, THE FINAL ANALYSIS IS PROVIDED ON PAGE 22 :

PR_Comment :

Analysis of ICAO Requirements

3.1.2.10.1.1 ***Reply ratio in the presence of interference***

Note.— The following paragraphs present measures of the performance of the Mode S transponder in the presence of interfering Mode A/C interrogation pulses and low-level in-band CW interference.

3.1.2.10.1.1.1 ***Reply ratio in the presence of an interfering pulse***.

Given a Mode S interrogation which requires a reply (3.1.2.4), the reply ratio of a transponder shall be at least 95 per cent in the presence of an interfering Mode A/C interrogation pulse if the level of the interfering pulse is 6 dB or more below the signal level for Mode S input signal levels between –68 dBm and –21 dBm and the interfering pulse overlaps the *P*6 pulse of the Mode S interrogation anywhere after the sync phase reversal. Under the same conditions, the reply ratio shall be at least 50 per cent if the interference pulse level is 3 dB or more below the signal level.

3.1.2.10.1.1.2 ***Reply ratio in the presence of pulse pair interference***.
Given an interrogation which requires a reply (3.1.2.4), the reply ratio of a transponder shall be at least 90 per cent in the presence of an interfering *P*1 – *P*2 pulse pair if the level of the interfering pulse pair is 9 dB or more below signal level for input signal levels between –68 dBm and –21 dBm and the *P*1 pulse of the interfering pair occurs no earlier than the *P*1 pulse of the Mode S signal.

3.1.2.10.1.1.3 ***Reply ratio in the presence of low level asynchronous interference***.

For all received signals between –65 dBm and –21 dBm and given a Mode S interrogation that requires a reply according to 3.1.2.4 and if no lockout condition is in effect, the transponder shall reply correctly with at least 95 per cent reply ratio in the presence of asynchronous interference. Asynchronous interference shall be taken to be a single Mode A/C interrogation pulse occurring at all repetition rates up to 10 000 Hz at a level 12 dB or more below the level of the Mode S signal.

Note*.— Such pulses may combine with the* P*1 and* P*2 pulses of the Mode S interrogation to form a valid Mode A/C-only all-call interrogation. The Mode S transponder does not respond to Mode A/C-only all-call interrogations.*

PR_Comment :

The note is not clear : Combine with P1 and P2 that means Case 1 and Case 4 / but it is a note and not a SHALL

RHS_Comment_11/27/2007 :

Agree that in this instance, Annex 10 only provides a note ; however, the actual requirement to not reply to Mode A/C-Only All-Call interrogations is provided in Annex 10 as follows :

3.1.2.4.1.2.2.2 *Mode A/C-only all-call interrogation acceptance.* A Mode A/C-only all-call interrogation shall not be accepted by a Mode S transponder.

Note.— The technical condition for non-acceptance of a Mode A/C-only all-call is given in the preceding paragraph by the requirement for rejecting an intermode interrogation with a P4 pulse having a trailing edge following the leading edge of P3 by less than 3.3 microseconds.

Therefore, the requirement to not reply to Mode A/C-Only All-Call interrogations is covered in Annex 10.

PR_Comment :

A preceding pulse may also combine with the P*2 of the Mode S interrogation to form a valid Mode A or Mode C interrogation. However, the* P*1 –*P*2 pair of the Mode S preamble takes precedence* ***(3.1.2.4.1.1.1).*** *The Mode S decoding process is independent of the Mode A/Mode C decoding process and the Mode S interrogation is accepted.*

PR_Comment :

In this case we combine with P2 as describe into Case 1 It is a note and not a SHALL

RHS_Comment_11/27/2007 :

Once again, it is agreed that this instance is only a note in Annex 10 ; however, the actual requirement is provided in Annex 10 as follows :

3.1.2.4.1.1.2 *Intermode interrogation recognition.* An intermode interrogation shall be recognized when a *P*1 - *P*3 -*P*4 pulse triplet meeting the requirements of 3.1.2.1.5.1 is received. An interrogation shall not be recognized as an intermode interrogation if:

a) the received amplitude of the pulse in the *P*4 position is smaller than 6 dB below the amplitude of *P*3; or

b) the pulse interval between *P*3 and *P*4 is larger than 2.3 microseconds or shorter than 1.7 microseconds; or

c) the received amplitude of *P*1 and *P*3 is between MTL and –45 dBm and the pulse duration of *P*1 or *P*3 is less than 0.3 microsecond; or

d) the transponder is in suppression (3.1.2.4.2).

If a *P*1 – *P*2 suppression pair and a Mode A or Mode C intermode interrogation are recognized simultaneously the transponder shall be suppressed.

Therefore, the requirement to suppress upon detection of P1-P2 is provided in the last paragraph of 3.1.2.4.1.1.2 of Annex 10.

PR_Comment :

3.1.2.4.1.1.1 *Mode A and Mode C interrogation recognition*.

A Mode A or Mode C interrogation shall be recognized when a *P*1 – *P*3 pulse pair meeting the requirements of 3.1.1.4 has been received, and the leading edge of a *P*4 pulse with an amplitude that is greater than a level 6 dB below the amplitude of *P*3 is not received within the interval from 1.7 to 2.3 microseconds following the leading edge of *P*3.
If a *P*1 – *P*2 suppression pair and a Mode A or Mode C interrogation are recognized simultaneously, the transponder shall be suppressed. An interrogation shall not be recognized as Mode A or Mode C if the transponder is in suppression (3.1.2.4.2).

PR_Comment :

Case 1 = ICAO Requirement

If a Mode A and a Mode C interrogation are recognized simultaneously the transponder shall complete the transaction cycle as if only a Mode C interrogation had been recognized.

PR_Comment :

Case 2 = ICAO requirement

ICAO don't consider cases 3 and 4.

EUROCAE ED-73B/C Provides:

Items shown in "red" font are the items that are being addressed in this discussion:

3.12.2 Simultaneous Interrogations of Mode A and Mode C

If a transponder recognises two valid pulse patterns simultaneously, it shall

a. enter the Mode A/C suppression state if one of the received pulse patterns is a P1-P2 suppression pair;

PR_Comment :

Case 1 without P6

b. and if one of the received pulse patterns is not a P1-P2 suppression pair, then generate a valid Mode C altitude reply if either of the two received pulse patterns is a Mode C interrogation.

PR_Comment :

Case 2

NOTE 1: *In a transponder equipped for diversity antenna operation, diversity channel selection takes place before all other processes.*

NOTE 2: *Simultaneous receipt of two interrogation pulse patterns can occur whenever there are two or more interrogators transmitting in the same airspace. For example,* **a single pulse from an interfering interrogator received 8 or 21 µs before the second pulse of a P1-P2 pair** *can cause the transponder to simultaneously recognise a Mode A/C interrogation and a Mode A/C suppression.*

PR_Comment :

Case 1 without P6

NOTE 3: *A single interference pulse received 8 µs before the P3 pulse of a Mode C interrogation (or 21 µs before the P3 pulse of a Mode A interrogation) can cause the transponder to simultaneously recognise both interrogation patterns. When this occurs, a Mode C reply is preferred because a missing Mode A reply usually causes less degradation of transponder tracking.*

PR_Comment :

Case 2

3.12.5 Pulse Pair Interference

a. The interfering signal shall consist of P1 and P2, spaced 2 µs apart, with a carrier frequency of 1030 ±0.2 MHz, and incoherent with the Mode S signal of the test.

b. The interfering pulse pair shall overlay any part of the Mode S interrogation except that the leading edge of the P1 interfering pulse shall occur no earlier than the P1 pulse of the Mode S signal.

c. Given an interrogation that demands a reply, the reply ratio of the transponder shall be at least 90% if the level of the interfering signals is 9 dB or more less than the signal levels for signal level inputs between -68 and -21 dBm.

NOTE: *This ensures the Mode S decoding is not inhibited by the receipt of Mode A/C side lobe suppression pulse pairs.*

d. **If a P1-P2 suppression pair and a Mode A or Mode C intermode interrogation are recognised simultaneously the transponder shall be suppressed.**

RHS_Comment_11/27/2007 :

Same requirement as second paragraph of Annex 10 section 3.1.2.4.1.1.1.

PR_Comment :

CASE 4

Bob, here I add the paragraph 3.12.4 to verify if all cases are covered.

RHS_Comment_11/27/2007 :

Don't see 3.12.4 listed, so I do not understand the comment.

3.12.3 Low Level Asynchronous Interference

a. For the purpose of this document, asynchronous interference is defined as single 0.8 ± 0.1 µs pulses with carrier frequency of 1 030 ±0.2 MHz,

incoherent with the Mode S signal carrier frequency and occurring at all repetition rates up to 10 000 Hz at a level 12 dB or more below that of the level of the Mode S signal.

b. In the presence of asynchronous interference, the transponder shall reply correctly to at least 95% reply of valid Mode S interrogations with received signal levels between -65 and -21 dBm, provided that no lockout condition is in effect.

NOTE 1: *Such pulses may combine with P1 and P2 pulses of the Mode S waveform to form a valid Mode A/C-Only All-Call waveform. The Mode S transponder shall not respond to Mode A/C-Only All-Calls but shall respond to the Mode S interrogation.*

PR_Comment :

Typically case 4

NOTE 2: A preceding pulse may also combine with the P2 of the Mode S waveform to form a valid Mode A or Mode C interrogation. Under such conditions, the P1-P2 pair of the Mode S preamble shall take precedence.

PR_Comment :

Typically case 1

RTCA DO-181C Provides: (Equivalent to ED-73B/C 3.12.2)

2.2.8.5 Simultaneous Interrogation of Mode A and Mode C

If a transponder receives two valid ATCRBS pulse patterns simultaneously, it shall:

a. Enter the ATCRBS suppression state if one of the received pulse patterns is a P_1-P_2 suppression pair.

b. Generate a valid Mode C reply if the two received pulse patterns are Mode A and Mode C interrogations.

Note: *Simultaneous receipt of two interrogation pulse patterns can occur wherever there are two or more interrogators transmitting in the same airspace. For example, a* single pulse from an interfering interrogator received 8 or 21 microseconds before the second pulse of a P_1- P_2 pair *can*

cause the transponder to simultaneously recognize an ATCRBS interrogation and an ATCRBS suppression. When this occurs, the Mode S transponder should enter the ATCRBS suppression state. It will thereby be enabled to receive the remainder as a possible interrogation waveform following the P_1- P_2 pair. A single interference pulse received 8 microseconds before the P_3 pulse of a Mode C interrogation (or 21 microseconds before the P_3 pulse of a Mode A interrogation) can cause the transponder to simultaneously recognize both interrogation patterns. When this occurs, a Mode C reply is preferred because a missing Mode A reply usually causes less degradation of beacon tracking.

DO-181C/D does not provide an equivalent test procedure to ED-73B/C section 5.4.7.2.e.

Discussion of Test Procedure:

We can summarised our analysis into the following table

	Requirements	*Case 1*	*Case 2*	*Case 3*	*Case 4*
ICAO					
	3.1.2.10.1.1.3 note	**Yes**			**Yes**
	3.1.2.4.1.1.1	**Yes**	**Yes**		
Eurocae					
	3.12.2	**Yes**	**Yes**		
	3.12.5-d				**Yes**
	3.12.3	**Yes**			**Yes**
RTCA					
	2.2.8.5	**Yes**	**Yes**		
	Tests				
Eurocae					
	5.4.7.2 Step 5				**Yes**

- **Nothing is defined related to the Case 3 , may be this point could be reported to ICAO. We have to discuss on this point.**

- **Case 1 and case 2 are clearly identified as a requirement by ICAO but not treated by Eurocae**

- **Case 4 is only evoked by ICAO in a note without "Shall"**

Bob proposed to change the Eurocae requirement to indicate that the interference pulse will be pace before P2. In this case we will move from case 4 to case 1. Case 2 will not be tested and Case 4 stay a requirement for Eurocae.

All these points have to be considered in the discussion.

EUROCAE ED-73C Provides:

5.4.7 Response in the Presence of Interference (Paragraph 3.12)

5.4.7.1 Test Equipment

a. 2 Transponder Test Sets.

b. Wide Band Dual Channel Oscilloscope.

c. 3 Port Power Divider.

5.4.7.2 Test Procedure

With the equipment connected as shown in Figure 5-5, interrogate the transponder with the Mode S-Only All-Call interrogation at a signal level of -50 dBm and follow Steps 1 through 4 below.

e. STEP 5 - Standard Interference Pulse Positioned at Mode A or Mode C Spacing before P_1 of a Mode S Interrogation (Paragraphs 3.12.2 a and 3.12.5 d)

Insert standard interfering pulse **8 µs before, and at the same signal level as, the P_1** pulse of a standard Mode S only All-Call interrogation.

PR_Comment :

Typically case 4

Check and record that the transponder replies to the Mode S only All-Call interrogation.

Insert a standard interfering pulse **21 µs before, and at the same signal level as, the P_1** pulse of a standard Mode S only All-Call interrogation.

PR_Comment :

Typically case 4

Check and record that the transponder replies to the Mode S only All-Call interrogation.

NOTE: *This test checks that the suppression pair is the recognised pulse pair by testing that the following P_6 is correctly decoded.*

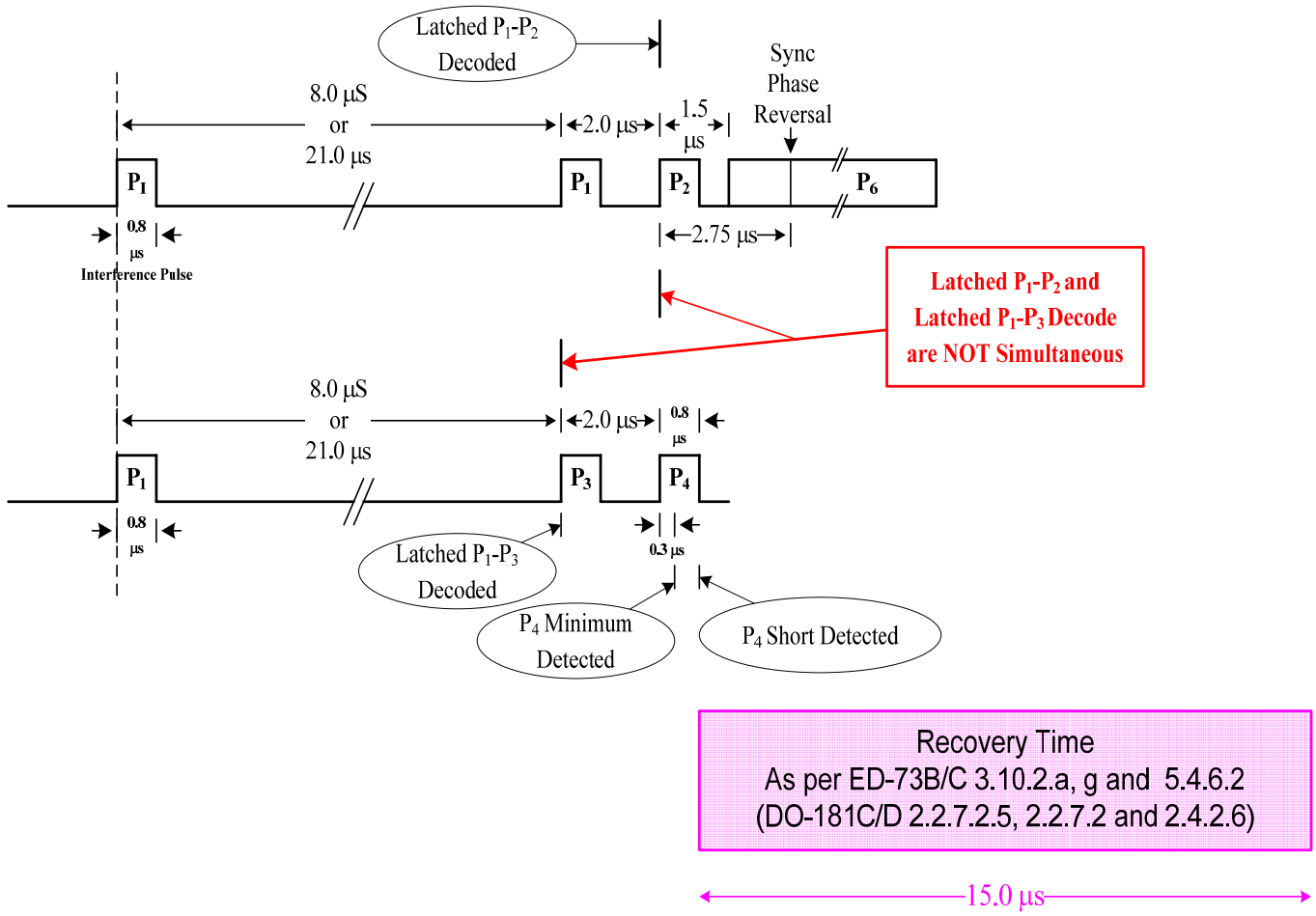
Analysis of Requirements and Test Procedures:

- **Figure 1 illustrates the waveform required by the ED-73B/C 5.4.7.2.e Test Procedure**
  - Note that procedure does not provide for simultaneous decode of a P_1-P_3 pulse pair and a P_1-P_2 pulse pair
  - Upon detection of the Short P_4 pulse, the transponder must reset and recover within 15 microseconds in order to process the next possible interrogation as per ED-73B/C and DO-181C/D as indicated Figure 1.
  - Note that the test procedure given in ED-73B/C section 5.4.7.2.e places the single interference pulse either 8 or 21 microseconds before the P_1 pulse of the P_1-P_2 pulse pair.
    - This is not consistent with ED-73B/C section 3.12.2, Note 2, which requires that the interference pulse be placed either 8

or 21 microseconds before the **second** pulse of the P_1-P_2 pair.

- **Figure 2 illustrates the waveform that is inferred by ED-73B/C section 3.12.2 and should be implemented in the 5.4.7.2.e Test Procedure**
  - Note that the P_1-P_3 Pair and the P_1-P_2 pair are decoded or detected simultaneously as required.
  - Transponder replies to the Mode-S-Only All-Call interrogation and ATCRBS processing is suppressed after detection of P_1-P_2

Figure 1: Waveform as required by Eurocae ED-73b/C section 5.4.7.2



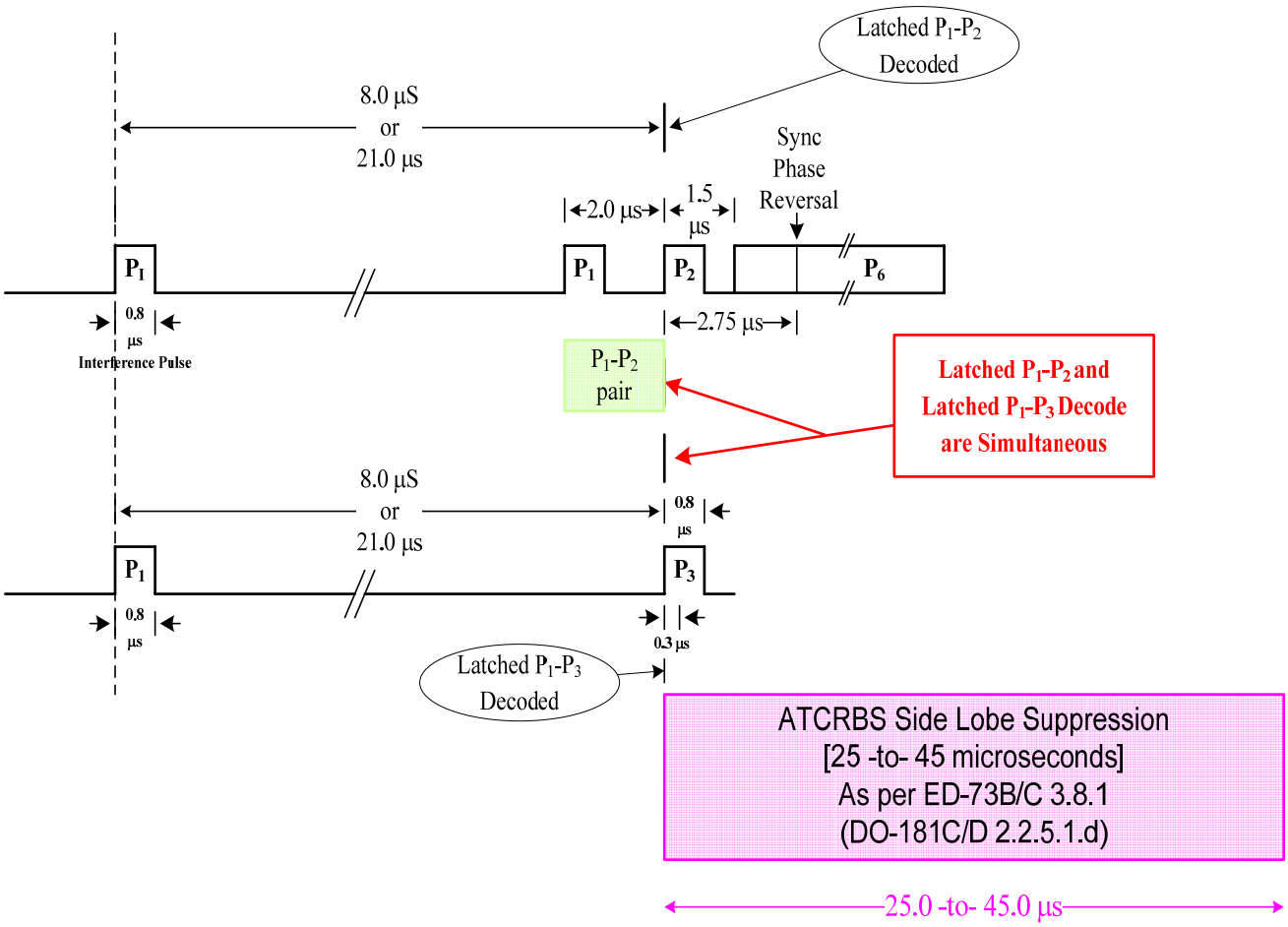
Upon detection of the latched P_1-P_3 condition, the transponder must prepare to transmit an ATCRBS reply within 3.0 +/- 0.5 µsec as measured from the leading edge of P_3 unless:

a. A short P_4 (0.8 µsec) is detected in which case the transponder shall not reply but recover (e.g., reset and get ready for the next interrogation within 15 µseconds, or

b. A Long P_4 (1.6 µsec) is detected in which case the transponder shall reply with an Mode-S All-Call (DF=11) reply within 128.0 +/- 0.5 µseconds after the receipt of P_4.

Does the transponder replies to a Mode S interrogation ?

Figure 2: Proper Waveform as required by Eurocae ED-73b/C section 3.12.2



Upon detection of the latched P_1-P_2 condition, the transponder must initiate the ATCRBS suppression for 25 -to- 45 microseconds, thereby disabling ATCRBS processing. Rather, the transponder must accept the Mode-S interrogation and reply with the appropriate Mode-S reply within 128 +/- 0.5 microseconds of the interrogation receipt.

Resolution of Issue:

ED-73B/C Test Procedure 5.4.7.2.e shall be changed to read as follows: (modifications are in "RED") *corresponding to case 1*

e. STEP 5 - Standard Interference Pulse Positioned at Mode A or Mode C Spacing before **P_2** of a Mode S Interrogation **P_1 – P_2 pulse pair** (Paragraphs 3.12.2 a and 3.12.5 d)

Insert standard interfering pulse 8 µs before **the P_2 pulse**, and at the same signal level as the P1 pulse of a standard Mode S only All-Call interrogation.

Check and record that the transponder replies to the Mode S only All-Call interrogation.

Insert a standard interfering pulse 21 µs before **the P_2 pulse**, and at the same signal level as, the P1 pulse of a standard Mode S only All-Call interrogation.

Check and record that the transponder replies to the Mode S only All-Call interrogation.

NOTE: *This test checks that the suppression pair is the recognised pulse pair by testing that the following P_6 is correctly decoded.*

RTCA SC-209 will then add the test procedure to section 2.4.2.6 of RTCA DO-181D as agreed by SC-209 during Meeting #8.

Other Issues with ED-73B/C Test Procedure 5.4.7.2:

- The first paragraph of the procedure refers to steps 1 through 4
  - Yet there are 6 steps in the procedure with only the first 5 being applicable to the first paragraph which calls out the use of Mode-S-Only All-Call interrogations.
    - Therefore, the first paragraph needs to be amended to call out at least steps 1 through 5.

- Step 6 of the procedure deals with Mode A and Mode C, but no Mode-S interrogations
  - Therefore, it is some what out of place under the main paragraph which calls out the use of Mode-S-Only All-Call interrogations.

– These inconsistencies need to be resolved if possible.

Final Analysis as of December 2, 2007, by RHS:

In regards to ED-73C section 5.4.7.2.e, step 5, Step 5 has been re-written to do the following:

Step 5: **Inserts interference pulse at Mode A/C spacing ahead of P2 of a P1-P2 suppression pair and requires that the transponder does not reply due to simultaneous detection of a P1-P3 and a P1-P2.**

THIS PROCEDURE COVERS DIRECT MOPS REQUIREMENTS AS LISTED IN THE PROCEDURE.

Step 6: **Insert interference pulse at Mode A/C Spacing ahead of P1 of a Mode-S interrogation and requires that the transponder does not reply as it is in a transaction cycle upon detection of a valid P1-P3. Note that the procedure allows the transponder to reply to the Mode-S transponder if it is designed to do so.**

THIS PROCEDURE COVERS THE CASE 4 SITUATION POSED BY PR, EUROCONTROL.

Step 7: **Insert interference pulse at Mode A/C Spacing ahead of P2 of a Mode-S interrogation and requires that the transponder replies to the Mode-S interrogation .**

THIS PROCEDURE COVERS THE CASE 1 SITUATION POSED BY PR, EUROCONTROL.

Step 8: **Inserts the interference pulse at Mode C Spacing ahead of the P4 pulse of a Mode A-Only All-Call and requires that the transponder not reply as it is in a transaction cycle upon detection of the P1-P3 Mode A and must reject all upon detection of the short P4. As such, this is not a simultaneous Mode A and Mode C detection.**

THIS PROCEDURE COVERS THE CASE 3 SITUATION POSED BY PR, EUROCONTROL.

CASE 2 OF THE PR, EUROCONTROL CONCERNS DOES NOT NEED TO BE ADDRESSED HEREIN OR IN THE FINAL TEST PROCEDURES AS IT IS ALREADY ADDRESSED UNDER SIMULTANEOUS MODE A AND MODE C INTERROGATIONS WHERE THE TRANSPONDER MUST REPLY WITH MODE C.

This concludes this analysis as of December 03, 2007, in regards to procedures provided in ED-73C, section 5.4.7.2.e, step 5 and on further.